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The Pregnant Brain as a Revving Race Car

Mothers-to-be get better at recognizing emotions

By Craig H. Kinsley and R. Adam Franssen | Tuesday, January 19, 2010 | 13 comments

What turns a young female concerned mainly about herself into a good mother who will make sure her offspring survive in an otherwise hostile world? The bodily changes of childbearing are obvious, but as we are discovering, the changes in the brain are no less dramatic.

The maternal brain is a formidable object, a singular entity forged by hormones, neurochemicals, and exposure to the ravening demands and irresistible cuteness of offspring. During pregnancy, the female brain is effectively revving up for the difficult tasks that await. A mother-to-be may most notice her cravings for ice cream and pickles, but inside her head, a transformation is afoot in fundamental functions ranging from attention to memory. As an intriguing new paper demonstrates, even her sensitivity to others' emotions increases.

Before we describe the new paper, let us contemplate the maternal brain in all of its wet majesty. Among its remarkable changes are those that allow the mother to focus on her infant in the persistent attempt to puzzle out the child's needs and wants. As any parent knows, the infant is inscrutable – indeed, the child remains so for much of the parent's life – and intuition is the mother's best friend. The parent tests hypotheses: Is the baby hungry? Tired? A sensitized brain facilitates these “experiments.” In humans, rodents and other animals, we find data showing that the mother's interest in, and motivation toward young increases dramatically as pregnancy nears term, and still further immediately following birth.

Underlying such change is a manifest shift in neuronal size, activity and capacity. Neurons in the part of the brain that largely regulate maternal behavior, called the medial preoptic area (mPOA), grow impressively during late pregnancy, increasing the protein-synthesizing capabilities of the cell. Like a race-car burning rubber before the green light, these mPOA neurons are readying themselves to respond to offspring stimuli with appropriate and sensitized impulses.

Further, in another brain region, the hippocampus, neurons are undergoing changes of another sort, leading to increases in the concentration of tiny projections on the surface of dendrites, called dendritic spines. These dendritic spines provide more neuronal surface and are believed to regulate inter-neuronal commerce. That the spines are increasing in the hippocampus, which controls learning and memory, suggests a possible function: enhancing memory, particularly spatial memory, that may be required of the new mother.

Fittingly, many data from numerous labs show that females with offspring have an increased facility for remembering the location of food caches and rewards in a variety of spatial environments. These females -- particularly multiparous females, those with two or more pregnancies under their belts -- are especially good at these tasks. Now, think about why: a mother that must leave her nest to forage for food – or her home for work – exposes both herself and her young to risk of predators and may benefit from an enhancement to her foraging skills or to the economy of her behavior, in general. The cost:benefit ratio decreases if she can find food and get back as quickly as possible to her lonely and vulnerable offspring.

In their recent paper, Rebecca Pearson of the University of Bristol's Academic Unit of Psychiatry and her co-authors add fuel to the race-car-burning-rubber theory. They find that not only are neurons ramping up their own activity levels, but that the hormones estrogen and progesterone are also intensifying emotive activity, helping mothers become more focused on their offspring and their

offspring's myriad cues.

In particular, Pearson's team looked at facial expressions depicting emotional states. In an elegantly designed experiment, they showed human mothers-to-be images of human faces, and asked them to rate the emotions expressed on those faces. As pregnancy progresses, mothers become more efficient at recognizing the emotions on the faces of others. Intriguingly, the greatest recognition increase pertains to faces exhibiting dangerous conditions – fear (perhaps of a visible threat), disgust (contamination threat), and anger (direct physical threat).

Normally calm women may be disturbed to find themselves suddenly beset by new fears and catastrophic visions while pregnant. Indeed, the authors compare pregnant women's threat-sensitivity levels to those found in people with anxiety disorders. But they suggest that the ability to recognize these threat conditions is an evolutionary adaptation to help females protect their offspring-to-be from harm.

The evolutionary tale rings true when considering post-partum primates. Anyone who has watched a human mother and her child knows that they gaze at one another in a way that suggests they are studying faces and expressions, a phenomenon examined by numerous researchers. Taking matters further, researchers have found that chimpanzee and rhesus macaque infants and mothers spend a significant amount of time gazing at one another, looking into and recognizing each other's faces. In photos, the primate mothers gazing at their infants bear a remarkable resemblance to "Madonna and Child" paintings. The researchers suggest that this emotional recognition helps with bonding and learning.

If studying the faces of offspring is mutually beneficial in the post-partum period, perhaps the increase in facial recognition during pregnancy is playing the dual role of protecting offspring from threats and preparing mothers for their unique bonding experience. That hypothesis would seem to be supported by the work of Ruth Feldman of Bar-Ilan University and colleagues, who in 2007 showed a correlation between the levels of oxytocin (the "love" and "bonding" hormone, which is also associated with the formation of breast milk) during pregnancy and the amount of time that mothers and infants spent gazing at one another. A race car peeling rubber indeed! This study, combined with Pearson's work, makes a strong argument that not only are hormones helping pregnant females defend their infants-to-be from the dangers in the world around them, but also preparing females to be loving mothers after giving birth.

The hormones do have a downside. Some new mothers suffer from depression and in rare cases, even psychosis. Research at Tufts University and elsewhere suggests some potential animal models and endocrinological mechanisms for postpartum mental distress, broadly defined. It suggests that hormones are to blame: an acute pull-back, addict-like, from the rich concentrations of steroids that characterize pregnancy may play a role in the severity of postpartum reactions.

So what about fathers? Are the dads among us doomed to stand idly by, clueless and bereft of meaningful emotional contact, while mothers reap the endocrinological, neurological, and emotional benefits of motherhood? Take heart, XY-ers! A 2008 study similar to Pearson's found that men administered oxytocin were better able to identify happy emotions in the faces of others. So, whereas we males may not receive a boost in our threat-response abilities, hormones in men may at least allow us not to loathe the occasional requisite diaper-changing.

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